BASLER L50/L75

USER'S MANUAL

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BASLER VISION TECHNOLOGIES

For customers in the U.S.A.

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

You are cautioned that any changes or modifications not expressly approved in this manual could void your authority to operate this equipment.

The shielded interface cable recommended in this manual must be used with this equipment in order to comply with the limits for a computing device pursuant to Subpart B of Part 15 of FCC Rules. In addition, the video data cable and power cable must have two ferrite cores with a diameter of 6.5 mm (one ferrite core at each cable end) to comply with the limits.

For customers in Canada

This apparatus complies with the Class A limits for radio noise emissions set out in Radio Interference Regulations.

Pour utilisateurs au Canada

Cet appareil est conforme aux normes Classe A pour bruits radioélectriques, spécifiées dans le Règlement sur le brouillage radioélectrique.

Life Support Applications

These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. Basler customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Basler for any damages resulting from such improper use or sale.

Warranty Note

Do not open the housing of the camera. The warranty becomes void if the housing is opened.

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1 Introduction

1.1 The Basler L50/L75 Product Family

L50/L75 series line scan cameras are versatile monochrome cameras designed for industrial use. Superb image sensing features are combined with high-speed data acquisition.

Important features are:

- High sensitivity
- Dark current correction circuitry allowing stable video signal during changes in surrounding temperature
- Industrial housing with easy positional adjustments using the optional camera holder
- Compact size
- Lightweight

L50/L75 line scan cameras are available in two different versions. The version depends on the sensor size. The **L50** sensor has 5000 pixels, the **L75** sensor has 7450 pixels.

1.2 Performance Specifications

Specifications	L50	L75
Sensor Type	Linear CCD	
Pixels	5000 pixels	7450 pixels
Pixel Size	7 µm (H) x 7 µm (V), 7 µm pitch	4.7 µm (H) x 4.7 µm (V), 4.7 µm pitch
Fill Factor	~ 100%	
Spectral Response	400 nm to 1200 nm, peak at 580 nm (see Figure 1-1)	
Photo Response Non-uniformity	±10% max	
Pixel Clock	40 MHz	
Maximum Line Rate	7.63 kHz	5.20 kHz
Minimum Line Rate	60 Hz	
Video Output	8 bit, RS-644 LVDS, single	
Synchronization	External via ExSync signal	
Exposure Time Control Mode	Edge-controlled	
Power Requirements	5 V DC (± 5%), max. 2.8 W (**L50**) or 3 W (**L75**) 15 V DC (± 5%), max. 4.5 W (**L50**) or 4.5 W (**L75**) -15 V DC (± 5%), max. 0.6 W (**L50**) or 0.6 W (**L75**)	
Max. Video Data Cable Length	11 m	
Lens Adapter	F-mount	
Housing Size (L x W x H)	76.2 mm x 65.0 mm x 65.0 mm (with F-mount adapter)	
Weight	~ 300 g (with F-mount adapter)	
Conformity	CE, FCC	

Table 1-1: **L50/L75** Performance Specifications

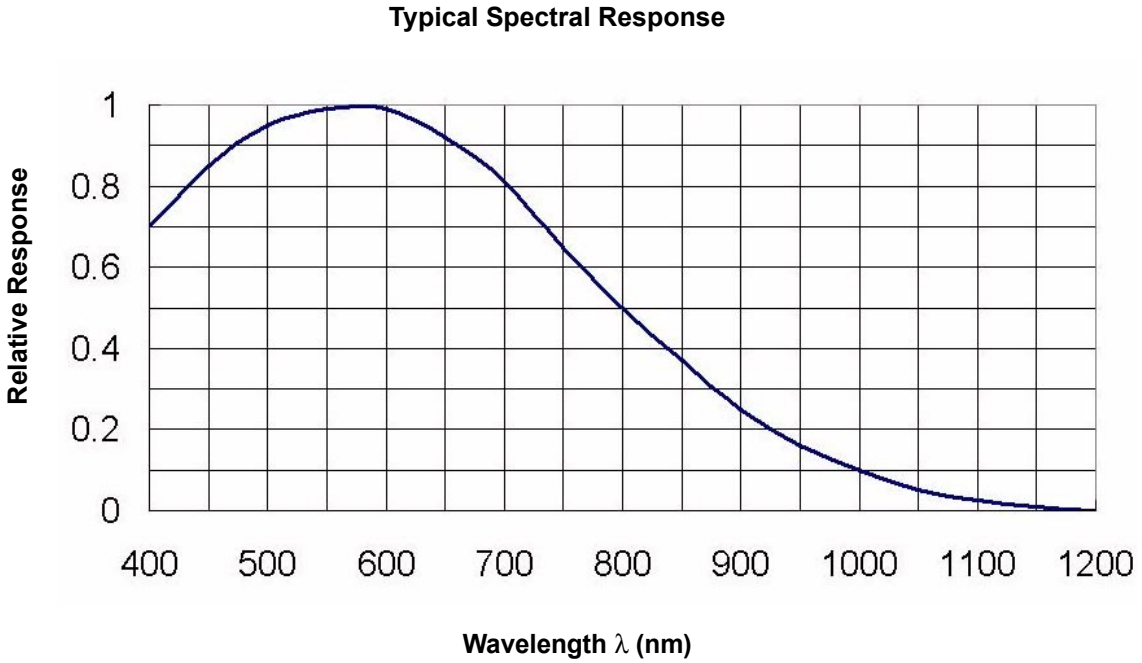

Figure 1-1: **L50/L75** Spectral Response (as Specified for the Sensor)

	The spectral response curve excludes lens characteristics and light source characteristics.

1.3 Precautions

Read the manual

Read the manual carefully before using the camera.

Power

	**Caution!** Be sure that all power to your system is switched off before you make or break connections to the camera. Making or breaking connections when power is on can result in damage to the camera. The camera is not protected for reverse voltage or overvoltage. If reverse voltage or overvoltage is applied to the camera while it is connected to a frame grabber in a PC, the camera could be seriously damaged. Refer to Table 2-2 on page 2-4 for information about the input power pin assignments.

Keep Foreign Matter Outside of the Camera

Do not open the camera housing. Touching internal components may damage them.

Be careful not to allow liquid, flammable, or metallic material inside the camera housing. If operated with any foreign matter inside, the camera may fail or cause a fire.

Ventilation

Allow sufficient air circulation around the camera or provide additional cooling to prevent internal heat build-up.

Warning!

Without sufficient cooling the camera can get hot enough during operation to cause burning when touched.

Environmental Requirements

Ambient temperature during operation:	0° C … +40° C (+ 32° F … +104° F)
Operation humidity:	5% … 85%, relative, non-condensing
Storage temperature:	-25° C … + 85° C (-13° F … +185° F)
Storage humidity:	5% … 85%, relative, non-condensing

Sunlight

Do not operate the camera in areas subject to direct sunlight.

Electromagnetic Fields

Do not operate the camera in the vicinity of strong electromagnetic fields. Avoid electrostatic charging.

Transporting

Only transport the camera in its original packaging. Do not discard the packaging.

Cleaning

Avoid cleaning the surface of the CCD sensor if possible. If you must clean it, use a soft, lint free cloth dampened with a small quantity of isopropyl alcohol. Do not use methylated alcohol.
Because electrostatic discharge can damage the CCD sensor, you must use a cloth that will not generate electrostatic charge during cleaning (cotton is a good choice).

To clean the surface of the camera housing, use a soft, dry cloth. To remove severe stains, use a soft cloth dampened with a small quantity of neutral detergent, then wipe dry.

Do not use volatile solvents such as benzine and thinners; they can damage the surface finish.

2 Camera Interface

2.1 Connections

2.1.1 General Description

L50/L75 series line scan cameras are interfaced to external circuitry via two connectors located on the back of the camera. Figure 2-1 shows the connector types used on the camera and Figure 2-2 provides a general description of the function of each connector. Figure 2-3 shows the pin numbering.

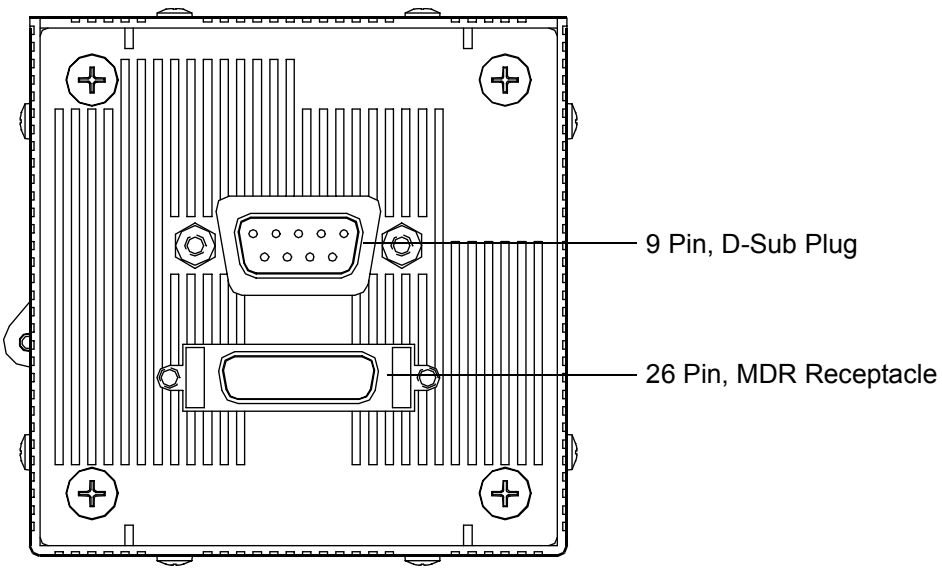

Figure 2-1: **L50/L75** Connector Types

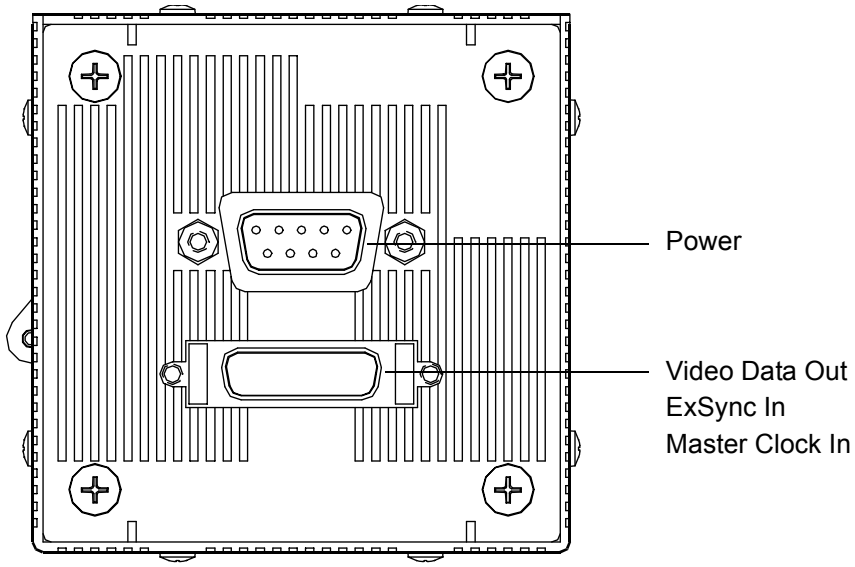

Figure 2-2: **L50/L75** Connector Functions

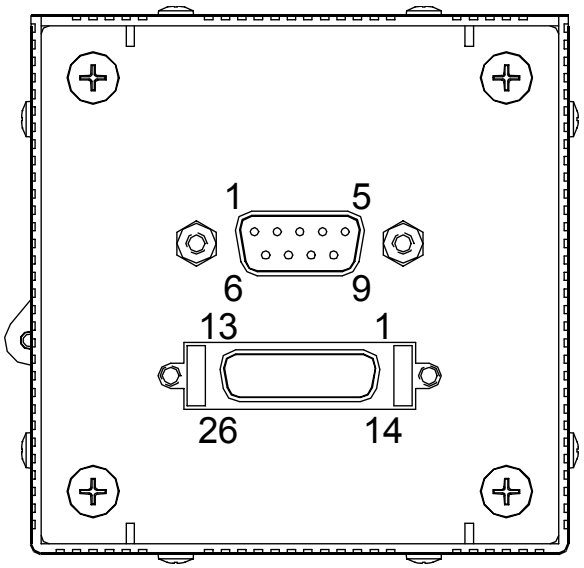

Figure 2-3: **L50/L75** Pin Numbering

2.1.2 Pin Assignments

26-Pin MDR Receptacle

The pin assignments for the 26 pin, MDR receptacle used to transmit video data, control signals, and configuration commands are shown in Table 2-1. The receptacle type is a Sumimoto3M, part number 10226-6202VC.

Pin Number	Signal Name	Direction	Level	Function
1	ExSync+	Input	RS-644 LVDS	External Trigger
14	ExSync-			
2	MCLK+	Input	RS-644 LVDS	Master Clock
15	MCLK-			
4	D0+	Output	RS-644 LVDS	Video Data (LSB)
17	D0-			
5	D1+	Output	RS-644 LVDS	Video Data
18	D1-			
6	D2+	Output	RS-644 LVDS	Video Data
19	D2-			
7	D3+	Output	RS-644 LVDS	Video Data
20	D3-			
8	D4+	Output	RS-644 LVDS	Video Data
21	D4-			
9	D5+	Output	RS-644 LVDS	Video Data
22	D5-			
10	D6+	Output	RS-644 LVDS	Video Data
23	D6-			
11	D7+	Output	RS-644 LVDS	Video Data (MSB)
24	D7-			
12	PCLK+	Output	RS-644 LVDS	Pixel Clock
25	PCLK-			
13	LVAL+	Output	RS-644 LVDS	Line Valid
26	LVAL-			
3, 16	DC Gnd	Input	Ground	DC Ground

Table 2-1: **L50/L75** Pin Assignments for the 26-pin MDR Receptacle

The camera housing is not grounded and is electrically isolated from the circuit boards inside of the camera.

9-Pin D-Sub Plug

The 9-pin D-Sub plug is used to provide power to the camera. The pin assignments for the plug are shown in Table 2-2.

Pin	Signal
1, 6 [1]	+5 V
2, 7 [2]	GND (+5 V)
3	+15 V
4	-15 V
5	Not connected
8	GND (+15 V)
9	GND (-15 V)

[1] Pins 1 and 6 are tied together inside of the camera.

[2] Pins 2 and 7 are tied together inside of the camera.

Table 2-2: **L50/L75** Pin Assignments for the 9-pin D-Sub Plug

2.2 Cable Information

2.2.1 Video Data Cable

The video data cable between the camera and the frame grabber must be made with 28 gauge AWG twisted pair wire and have a characteristic impedance of 100 ohms.

The maximum length of the cable is 11 m.

2.2.2 Power Cable

For proper EMI protection, the power supply cable attached to the 9-pin D-Sub plug must be a twin-cored, shielded cable. Also, the housing of the 9-pin D-Sub plug must be connected to the cable shield and the cable must be connected to earth ground at the power supply.

Power requirements are given in Section 2-4. A suitable power supply is available from Basler as a stock item.

The shielded interface cable recommended in this manual must be used with this equipment in order to comply with the limits for a computing device pursuant to Subpart B of Part 15 of FCC Rules. In addition, the video data cable and power cable must have two ferrite cores with a diameter of 6.5 mm (one ferrite core at each cable end) to comply with the limits.

2.3 Video Data and Control Signals

All video data and control signals on the **L50/L75** series cameras use LVDS technology as specified for RS-644. Detailed information on RS-644 appears in Section 2.3.3.

2.3.1 Input Signals

2.3.1.1 ExSync: Controls Line Readout and Exposure Time

The camera functions in edge-controlled exposure time control mode. In this mode, an external trigger (ExSync) signal is used to control exposure time and line read out. For more detailed information, see Section 3.2.

ExSync can be a periodic or non-periodic function. The frequency of the ExSync signal determines the camera's line rate.

Minimum high level time for the ExSync signal is two pixel clock cycles, that is, 50 ns. Maximum high level time for the ExSync signal is 30 pixel clock cycles, that is, 750 ns. Note that ExSync is edge sensitive and therefore must toggle.

2.3.1.2 Master Clock

The master clock (MCLK) drives the camera's line CCD and is supplied externally at a clock rate of 40 MHz. The high level time for the master clock signal must be approximately as long as the low level time (± 20%).

2.3.2 Output Signals

2.3.2.1 LVAL: Indicates a Valid Line

LVAL indicates a valid line of data as illustrated in Figure 2-4. Video data is valid when LVAL is high.

2.3.2.2 Pixel Clock: Indicates a Valid Pixel

Pixel clock indicates a valid pixel of data as illustrated in Figure 2-4. The LVAL and the pixel clock signal are used to clock the digital video output data into external circuitry. The length of one pixel clock cycle is 25 ns. The pixel clock rate is 40 MHz. Digital data is valid on the rising edge of the pixel clock signal with LVAL high.

2.3.2.3 Video Data

L50/L75 cameras output pixels as a single data stream as shown in Figure 2-4. On each pixel clock, the camera transmits data for one pixel at 8 bit depth and a line valid bit (LVAL). D_7 is the most significant bit of video data, D_0 is the least significant bit.

The pixel clock is used to time data sampling and transmission.

The pixels are in sequential order, starting with the first valid pixel and ending with the last pixel. No further sorting is required.

The whole range of intensity includes 256 gray values. The digital gray value 0 corresponds to black and the digital gray value 255 to white.

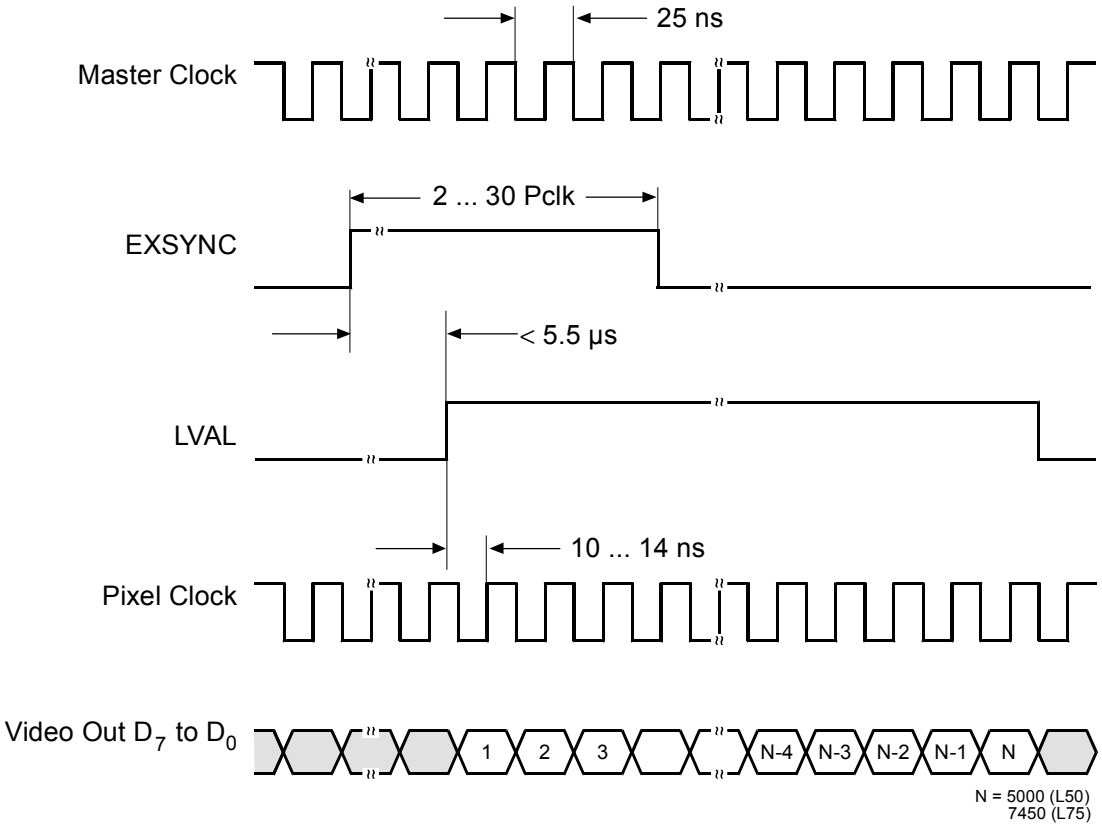

Figure 2-4: **L50/L75** Pixel Timing, Edge-controlled Exposure Mode

2.3.3 LVDS and RS-644 Information

All video data and control signals on **L50/L75** series cameras use LVDS technology as specified for RS-644. Basic RS-644 characteristics are outlined in Table 2-3.

L50/L75 cameras use National Semiconductor DS90C031 differential line drivers to generate LVDS output signals and a National Semiconductor DS90C032 differential line receiver to receive LVDS input signals. Detailed spec sheets for these devices are available at the National Semiconductor web site (www.national.com).

	RS-644
Low, High Voltage Level (min./max.)	1.0 V, 1.4 V
Voltage Swing (typical)	± 0.35 V
Receiver Threshold	± 0.10 V
Receiver Input Voltage Tolerance	0.0 V to 5.0 V [1]
Termination	100 Ohm
Max. Data Rate per Line Pair	655 MBits/s [2]
Max. Cable Length at 40 MHz [3] (typical)	11 m
Power Requirements (transmitter + receiver) for 20 line pairs at 20 MBits/s (typical)	0.93 W

[1] Device-dependent, 5V devices handle this range

[2] Device-dependent

[3] Note that the frequency refers to the pixel clock and not the number of pixels transferred per clock cycle

Table 2-3: RS-644 Characteristics

2.3.4 Converting TTL to RS-644

In many cases, ExSync signals in RS-644 format are generated by a frame grabber board. In some situations, however, you may want to generate an ExSync signal directly from a TTL device such as a sensor. Figure 2-5 illustrates a simple circuit that can be used to convert TTL signals to RS-644 compatible signals.

The circuit produces a symmetric 200mV output. The 5V power required for the circuit can be found on many frame grabbers on the GPIO port. There is no significant time delay due to the TTL to RS-644 conversion.

A disadvantage to this circuit is the constantly existing DC current of approximately 5 mA.

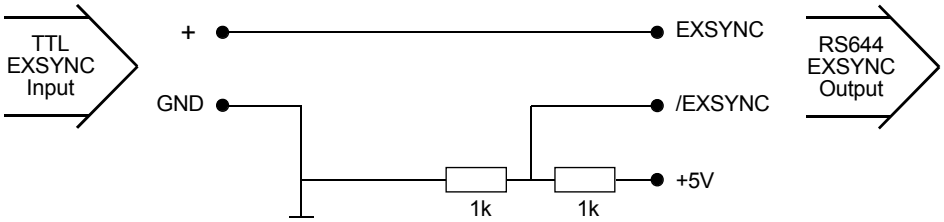

Figure 2-5: TTL to RS-644 Conversion

2.4 Power Supply

L50/L75 series cameras require three voltages, +5V, +15V and -15V. A suitable power supply is available from Basler. Ripple must be less than ± 5%.

The maximum power consumption is given in Table 2-4.

Power Supply	Maximum Power Consumption	
	L50	L75
5 V DC	2.8 W	3 W
15 V DC	4.5 W	4.5 W
-15 V DC	0.6 W	0.6 W

Table 2-4: Power Consumption

Caution!

Be sure that all power to your system is switched off before you make or break connections to the camera. Making or breaking connections when power is on can result in damage to the camera.

The camera is not protected for reverse voltage or overvoltage. If reverse voltage or overvoltage is applied to the camera while it is connected to a frame grabber in a PC, the camera could be seriously damaged. Refer to Table 2-2 on page 2-4 for information about the input power pin assignments.

3 Basic Operation and Features

3.1 Functional Description

L50/L75 series line scan cameras use a CCD sensor chip which provides an electronic exposure time control. Exposure is controlled via an external ExSync signal. The ExSync signal facilitates asynchronous pixel readout.

Exposure time is edge-controlled, which means exposure time is set to the full line period of the ExSync signal. The rising edge of ExSync triggers the readout of accumulated charges from the sensor elements to the CCD shift registers.

The accumulated charges are transported from the light-sensitive sensor elements to the CCD shift registers. The charges from odd and even pixels are processed separately in two channels. The charges then move from the two lines of shift registers to the output amplifiers where they are converted to voltages proportional to the accumulated charges. The shift register is clocked according to the camera's internal data rate. The overall output data rate is fixed at 40 MHz.

The voltages are digitized and transferred from the camera. The video data is transmitted as a single 8 bit video data stream depending on the camera settings. All output signals use LVDS technology as specified for RS-644.

3.2 Exposure Time Control

The camera's line rate and exposure time are controlled by an externally generated (ExSync) signal. Charge is accumulated over the full line period of the ExSync signal (rising edge to rising edge). The falling edge of ExSync is irrelevant. The line is read out and transferred with the rising edge of ExSync. The length of the ExSync signal determines the line rate. See Figure 3-1.

This exposure time control mode is called "edge-controlled".

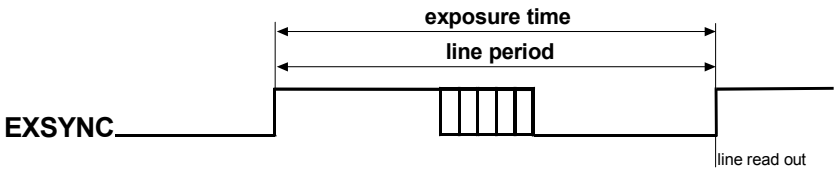

Figure 3-1: Edge-controlled Exposure Time Control

4 Mechanical Considerations

4.1 Dimensions

The camera's sensor and electronics are housed in an aluminum case. Dimensions are given in the diagram in Figure 4-1. All dimensions are in mm.

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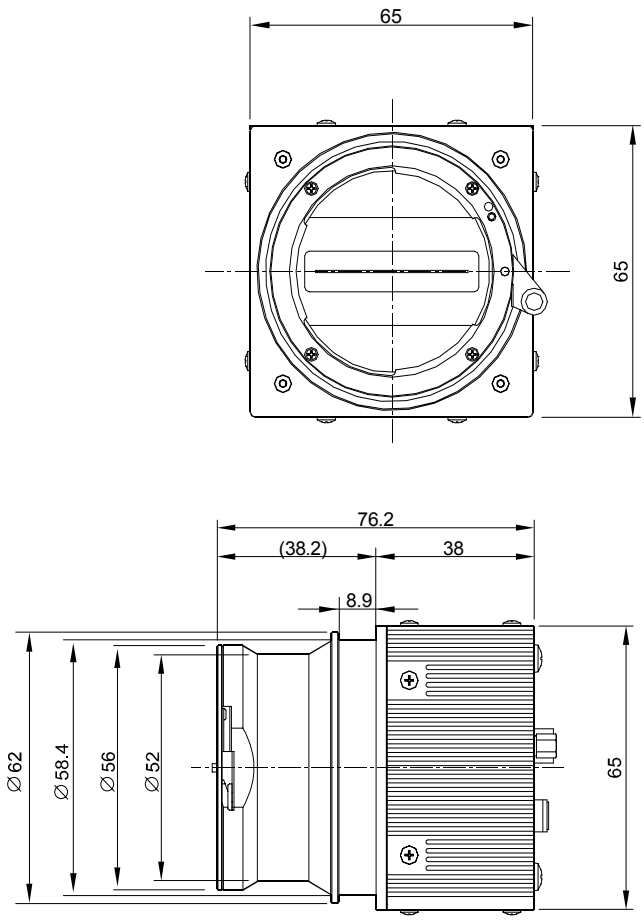


Drawings are
NOT TO SCALE.

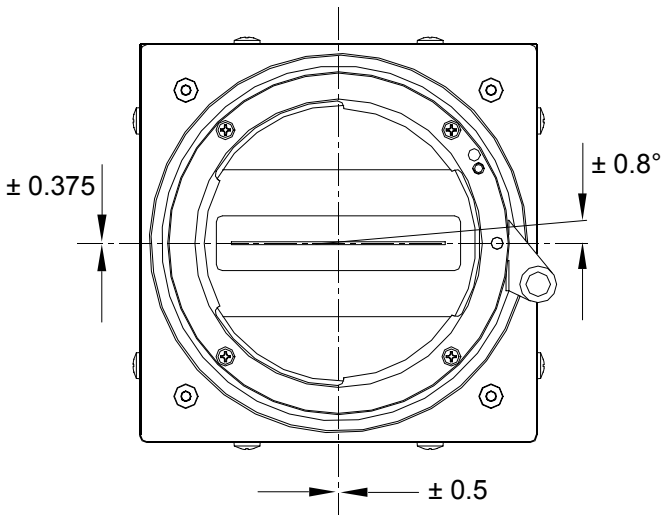
Figure 4-1: Mechanical Dimensions [in mm] (Front View / Side View)

4.2 Positioning Accuracy of the Sensor Chip

Translatory and rotational positioning accuracy of the sensor chip is as shown in Figure 4-2.

Since the translatory and rotational positioning tolerance depend on each other, the worst case of maximum rotational and horizontal/vertical mis-positioning cannot occur at the same time.

The maximum tilt of the sensor chip is ±0.56°.



Drawings are
NOT TO SCALE.

Figure 4-2: Sensor Positioning Accuracy

4.3 Mounting Facilities

Optionally, **L50/L75** series cameras can be equipped with a camera holder. It is mounted around the F-mount adapter of the camera. A clamping screw fastens the camera. The camera holder has four mounting holes as indicated in Figure 4-3.

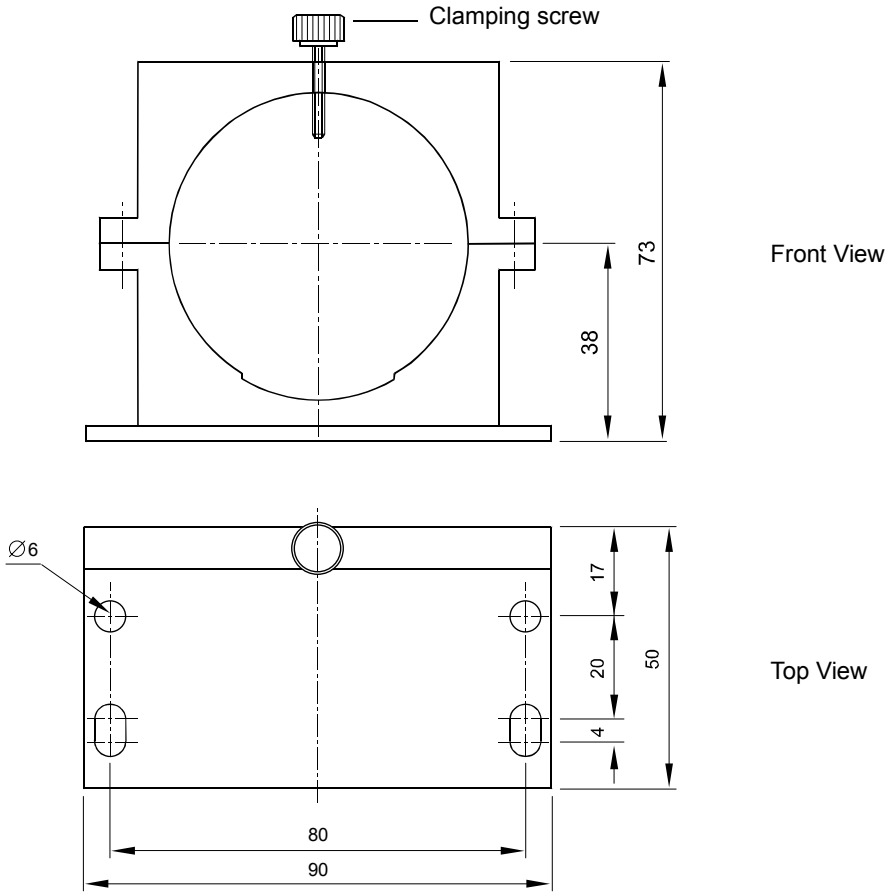


Figure 4-3: Camera Holder

4.4 Optical Interface

An adapter for F-mount lenses is available for all **L50/L75** series cameras.

When choosing a lens, ensure that the image circle diameter of the lens is at least as great as the length of the photosensitive sensor area.

Caution!

To avoid collecting dust on the sensor, mount a lens on the camera immediately after removing the dust cap.

5 Troubleshooting

The following pages contain several troubleshooting checklists which can help you find the cause of problems that users sometimes encounter. The checklists assume that you are familiar with the camera's features and settings and with the settings for your frame grabber. If you are not, we suggest that you review the manuals for your camera and frame grabber before you troubleshoot a problem.

5.1 No Image

Use this checklist if you see no image at all when you attempt to capture an image with your frame grabber (in this situation, you will usually get a message from the frame grabber such as “time-out”), or if the camera sends no line valid (LVAL) signal.

If you see a completely white image, a completely black image, or if you have other image quality problems, use the checklists in Section 5.2.

Caution!

Be sure that all power to your system is switched off before you make or break connections to the camera. Making or breaking connections when power is on can result in damage to the camera.

The camera is not protected for reverse voltage or overvoltage. If reverse voltage or overvoltage is applied to the camera while it is connected to a frame grabber in a PC, the camera could be seriously damaged.

Make sure that the following requirements are met:

- ☐ Power is applied to the camera and it meets the specifications shown in Section 2.4. Use a voltmeter to check the power source for the camera.
- ☐ The power cable is plugged into the camera and the power source.
- ☐ The data cable between the camera and the frame grabber is properly fabricated (see Section 2.2). Using a lower quality cable or non-twisted pair cable can result in poor image quality.
- ☐ The data cable is plugged into the camera and the frame grabber.
- ☐ The Master Clock (MCLK) signal and the ExSync signal are present.
- ☐ The camera is not operating in the vicinity of strong electromagnetic fields or other sources of electrical noise.
- ☐ Check the setup on your frame grabber and make sure that the ExSync signal is not too short, that is, the line rate does not exceed the allowed maximum (see Section 2.3.1.1). (On many frame grabbers, the period of the ExSync signal is adjusted by changing a setting for the “line rate”. Your line rate should not exceed the limit shown in Table 1-1 on page 1-2.)

If the problem is still present, contact Basler Technical Support. The contact numbers appear on the title page of this manual.

5.2 Image Quality Problems

Use this section if the image is completely white, if the image is completely black, or if you have other image quality problems. If you get no image at all when you attempt to capture an image with the frame grabber, use the checklist that appears in Section 5.1.

5.2.1 Image Is Completely White

Do the following:

- ☐ Try decreasing the intensity of your light source or moving the light source away from your object. Your light source must not be too bright.
- ☐ Try closing the lens aperture.
- ☐ Make sure that the camera's position is correct.

If the problem is still present, contact Basler Technical Support. The contact numbers appear on the title page of this manual.

5.2.2 Image Is Completely Black

Go through the checklist in Section 5.1. If the problem is still present afterwards, do the following:

- ☐ Try increasing the intensity of your light source or moving the light source closer to your object. Your light source must not be too dark.
- ☐ Make sure that the lens cap has been removed.
- ☐ Try opening the lens aperture.
- ☐ Make sure that no black target is in the camera's field of view.
- ☐ Make sure that the camera's position is correct.
- ☐ Use an ohm meter to check the wires in the video data cable. Make sure that there are no broken wires and that no wires are shorted together.

If the problem is still present, contact Basler Technical Support. The contact numbers appear on the title page of this manual.

5.2.3 Horizontal Lines or Stripes in the Image

Make sure that:

- ☐ You use a constant illumination source such as a DC halogen lamp or a bank of fluorescent tubes specifically designed to provide a constant light level. Do not use a low-frequency light source such as a single flourescent tube or AC lamp.

If the problem is still present, contact Basler Technical Support. The contact numbers appear on the title page of this manual.

5.2.4 Vertical Black Lines or Stripes in the Image

Dust or dirt on the camera's objective lens or sensor chip may cause the lines or stripes. Go through the following checklist:

- ☐ Use a soft, lint free cloth dampened with a small quantity of isopropyl alcohol to clean the objective lens.
- ☐ Use a soft, lint free cloth dampened with a small quantity of isopropyl alcohol to clean the camera's sensor chip.

If the problem is still present, contact Basler Technical Support. The contact numbers appear on the title page of this manual.

5.2.5 Random Horizontal Black Lines in the Image

Make sure that:

- ☐ The camera is not operating in the vicinity of strong electromagnetic fields or other sources of electrical noise.

If the problem is still present, contact Basler Technical Support. The contact numbers appear on the title page of this manual.

5.2.6 White or Black Lines, or Points on Black/White Transitions

Do the following:

- ☐ Check the setup on your frame grabber and make sure that the ExSync signal is not too short, that is, the line rate does not exceed the allowed maximum (see Section 2.3.1.1). (On many frame grabbers, the period of the ExSync signal is adjusted by changing a setting for the "line rate". Your line rate should not exceed the limit shown in Table 1-1 on page 1-2.)

If the problem is still present, contact Basler Technical Support. The contact numbers appear on the title page of this manual.

Revision History

Document Number	Date	Changes
DA00064501	17 Dec 2003	Initial draft release version of this manual.
DA00064502	10 June 2004	Initial release version of this manual.

Feedback

Your feedback will help us improve our documentation. Please click the link below to access an online feedback form. Your input will be greatly appreciated.

http://www.baslerweb.com/umfrage/survey.html

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